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(54) CIRCUIT AND METHOD FOR IMAGE PROCESSING

(57)Abstract:
PROBLEM TO BE SOLVED: To compress a dynamic range with high compressibility by applying a circuit and a method for image processing to, for example, a video camera, an electronic still camera, etc., and effectively avoiding a decrease in contrast feeling and unnatural edge enhancement.
SOLUTION: An input image X is smoothed while holding its edge to find a gain correction coefficient G, with which pixel values x(i,j) of the input image X are corrected.

CLAIMS

[Claim(s)]
[Claim 1]An image processing circuit which compresses a dynamic range of an inputted image, comprising:
A smoothing means which saves edge of said inputted image and smooths a pixel value of said inputted image.
A correction factor creating means which generates a gain correction coefficient according to an output value of said smoothing means.
A pixel value compensation means which amends a pixel value of said inputted image with said gain correction coefficient.

[Claim 2]An image processing method which compresses a dynamic range of an inputted image, comprising:
Data smoothing which saves edge of a picture by said inputted image, and smooths a pixel value of said inputted image.
Correction factor generation processing which generates a gain correction coefficient according to an output value of said data smoothing.
A pixel value compensation process which amends a pixel value of said inputted image with said gain correction coefficient.

[Claim 3]The image processing method according to claim 2 having the gray-level-correction processing which amends gradation of a pixel value amended by said pixel value compensation process.
[Claim 4]The image processing method according to claim 2 having the image enhancement processing which emphasizes change of a pixel value amended by said pixel value compensation process using a subtraction value acquired by subtracting an output value by said data smoothing from a pixel value of said inputted image.
[Claim 5]The image processing method comprising according to claim 2:
Noise rejection processing which removes a noise of said inputted image a priori.
Dynamic range expanding processing which carries out the multiplication of the pixel value of said said inputted image which carried out noise rejection processing by a

uniform profit, expands a dynamic range, and is supplied to said data smoothing and said pixel value compensation process.

[Claim 6]The image processing method comprising according to claim 2:
Filtering processing from which said data smoothing extracts low frequency components from said inputted image.
Logarithmic transformation processing which log transforms said pixel value which carried out filtering processing.
Non-line type filtering processing which saves edge of said picture which carried out logarithmic transformation processing, and oppresses a high frequency component.
An inverse logarithm conversion process which carries out inverse logarithm conversion of the pixel value by said non-line type filtering processing.

[Claim 7]The image processing method according to claim 6, wherein said non-line type filtering processing repeats two or more filtering which sampling pitches of a pixel value in said inputted image differ, and saves edge of a picture, and oppresses a high frequency component and is performed.
[Claim 8]The image processing method according to claim 6, wherein said non-line type filtering processing samples a continuous pixel with a predetermined pitch and is performed.
[Claim 9]The image processing method comprising according to claim 6:
Processing of approximation-functions generation in which said non-line type filtering processing generates predetermined approximation functions which approximate low frequency components of a pixel value of this pixel about a pixel of a prescribed range on the basis of a pixel of a processing object.
Processing of field setting out in which a field corresponding to said low frequency components is set up on the basis of said approximation functions.
Replacement processing of a pixel value which judges whether a pixel value belongs to said field about each of a pixel of a prescribed range on the basis of a pixel of said processing object, and transposes a pixel value concerning this judgment to a corresponding pixel value by said approximation functions selectively according to this decision result.
Processing of weighting addition which carries out weighting addition of the pixel value by replacement processing of said pixel value.

[Claim 10]The image processing method according to claim 2, wherein the characteristic of said gain correction coefficient to an output value of said data smoothing is the monotone decreasing characteristic.
[Claim 11]The image processing method according to claim 5, wherein said noise rejection processing is coring processing.

[Claim 12]The image processing method according to claim 5, wherein said noise rejection processing is processing by a median filter.
[Claim 13]The image processing method comprising according to claim 6:
Replacement processing of a pixel value which replaces selectively a pixel value which requires said noise rejection processing for this judgment according to a judgment on the basis of a pixel value of a pixel of said processing object about a pixel of a prescribed range on the basis of a pixel of a processing object.
Processing of weighting addition which carries out weighting addition of the pixel value by replacement processing of said pixel value.

[Claim 14]The image processing method comprising according to claim 2:
A normalizing process which normalizes a color difference signal element of said inputted image a priori by a luminance signal component of said inputted image, and supplies a pixel value by said luminance signal component to said data smoothing and said pixel value compensation process.
A color-difference-signal compensation process which amends a pixel value of said color difference signal element by which the normalizing process was carried out with a pixel value by said luminance signal component by which the pixel value compensation process was carried out.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention about an image processing circuit and an image processing method For example, a video camera, It is applicable to image processing with the image display in processing of the image pick-up result in an electronic "still" camera etc., record, a liquid crystal display, etc., a personal computer, etc., picture composition, and transmission of the picture according to these further. In this invention, an inputted image is smoothed with edge saved, a gain correction coefficient is calculated, and this gain correction coefficient amends the pixel value of an inputted image.
Therefore, the fall of a contrast feeling and unnatural edge enhancement are avoided effectively, and it enables it to compress a dynamic range with a high compression ratio.

[0002]
[Description of the Prior Art]Conventionally, in various image processing circuits, such as an imaging device, it is made as [perform / compress the dynamic range of a picture

and / processing of versatility, such as record and reproduction,].

[0003]As processing which compresses such a dynamic range, There are a method of amending the gradation of the whole picture and the method of amending gradation only about the low frequency components of a picture, and it is made in the former as [compress / a gamma correction, knee amendment, what is called histogram equivalence, etc. amend gradation, and / a dynamic range]. On the other hand, in the latter, it is made as [compress / by a gamma correction, knee amendment etc. / a dynamic range].

[0004]

[Problem(s) to be Solved by the Invention]However, if it was in these dynamic-range-compression methods, there was a problem insufficient practically still.

[0005]That is, if it is in the method of amending the gradation of the whole picture by a gamma correction, knee amendment, etc., in the luminosity region of a highlight part, a luminosity region with few histograms, etc. which is a compression object of contrast, the contrast of a photographic subject is also compressed simultaneously with a dynamic range. Thereby, in the case of this method, it was difficult to enlarge the compression ratio of a dynamic range, and there was a problem by which a picture without the contrast in which contrast deteriorated by compression of the dynamic range is generated.

[0006]On the other hand, if it is in the method of amending gradation by a gamma correction, knee amendment, etc. only about the low frequency components of a picture, the ratio of the low-frequency component of a picture and a high frequency component changes with compression of a dynamic range. Thereby, in the case of this method, edge was unnaturally emphasized by compression of the dynamic range, and there was a problem by which an undignified picture is generated.

[0007]This invention was made in consideration of the above point, tends to avoid the fall of a contrast feeling, and unnatural edge enhancement effectively, and tends to propose the image processing circuit and image processing method which can compress a dynamic range with a high compression ratio.

[0008]

[Means for Solving the Problem]In order to solve this technical problem, in an invention of claim 1 or claim 2, it applies to an image processing circuit or an image processing method, and edge of an inputted image is saved, a pixel value of an inputted image is smoothed, a gain correction coefficient is generated according to an output value of this smoothing, and a pixel value of an inputted image is amended.

[0009]According to composition of claim 1 or claim 2, edge of an inputted image is saved, and if a pixel value of an inputted image is smoothed, from an inputted image, only an ingredient which determines a dynamic range of a picture can be taken independently, and it can come out, and can carry out. If this generates a gain correction coefficient according to an output value of this smoothing and a pixel value of an

inputted image is amended, About contrast of a photographic subject in which to save without [independent of a dynamic range of a picture] compressing is desired, degradation can be avoided effectively, and a dynamic range can be compressed with a desired compression ratio. A dynamic range of an inputted image can be compressed with a high compression ratio, also being able to prevent unnatural edge enhancement and maintaining grace of an inputted image by these by degradation being effectively avoidable about contrast of a photographic subject.

[0010]

[Embodiment of the Invention]Hereafter, an embodiment of the invention is explained in full detail, referring to drawings suitably.

[0011](1) Entire configuration drawing 1 of a 1st embodiment of composition (1-1) of a 1st embodiment is a block diagram showing the image processing circuit concerning a 1st embodiment of this invention. This image processing circuit 1 is applied to imaging devices, such as a video camera and an electronic "still" camera, various image processing devices, picture transmission equipment, image processing [in / further / a personal computer], etc., compresses the dynamic range of the inputted image X, and carries out the outputted image Y.

[0012]The inputted image X and the outputted image Y are two-dimensional digital images, below, express horizontal and the position of a pixel in a perpendicular direction with the numerals i and j, respectively, and express the pixel value of the inputted image X and the outputted image Y to it by x (i, j) and y (i, j) here, respectively. Each processing value corresponding to these pixel values x (i, j) and y (i, j) is similarly shown using the numerals i and j.

[0013]In this image processing circuit 1, as shown in drawing 2 (A), the non-line type smoothing machine 2 smooths the pixel value x of the inputted image X by a big dynamic range inputted (i, j), and outputs the smoothed image S by the pixel value s (i, j) (drawing 2 (B)). When each pixel value x (i, j) judges whether it is a thing in edge and processes from the pixel value information on an inputted image, and spacial information, the non-line type smoothing machine 2 smooths only a small-size width ingredient, and is kept from performing processing of smoothing about a big edge component in processing of this smoothing. Thereby, the non-line type smoothing machine 2 smooths the pixel value x of the inputted image X (i, j), with edge saved, and is made as [take / only the ingredient which determines the dynamic range of a picture / independently].

[0014]The look-up table (LUT) 3 outputs gain correction coefficient g (i, j) (drawing 2 (C)) for amending the pixel value x of the inputted image X (i, j) on the basis of the pixel value s of the smoothed image S outputted from the non-line type smoothing machine 2 (i, j). By this gain correction coefficient g's (i's, j's) amending the pixel value x of the inputted image X (i, j), and compressing a dynamic range here in the image processing circuit 1, The look-up table 3 outputs this gain correction coefficient g (i, j)

with the input-output behavioral characteristics which have the monotone decreasing characteristic as shown, for example in drawing 3. In the input-output behavioral characteristics shown in this drawing 3 here, The pixel value s of the smoothed image S (i, j) in being smaller than the predetermined value s1, outputting gain correction coefficient g (i, j) of the values 1 and 0 -- the pixel value s of the smoothed image S (i.) It is the characteristic that j) follows on increasing from this predetermined value s1, gain correction coefficient g (i, j) decreases exponentially, and gain correction coefficient g (i, j) becomes the value g1 at the maximum s max of the pixel value s (i, j).

[0015]With such input-output behavioral characteristics, the look-up table 3, For example, when the pixel value x of the inputted image X (i, j) has risen before and behind edge with change of a small pixel value as shown in drawing 2 (A), The pixel value s of the smoothed image S in which it comes to remove change of a small pixel value (i, j) is acquired, and gain correction coefficient g with a small value (i, j) (drawing 2 (C)) is outputted as the part where the pixel value s of this smoothed image S (i, j) is small. By saving edge in the pixel value s of the smoothed image S (i, j) at this time, in the portion of edge, the look-up table 3 outputs gain correction coefficient g (i, j) so that a value may change rapidly.

[0016]The delay circuit 4 only the part of the time which processing of the image data in the non-line type smoothing machine 2 and the look-up table 3 takes, The specified time lag of the image data which constitutes the inputted image X is carried out, to gain correction coefficient g (i, j) outputted from the look-up table 3 by this, timing doubling of the pixel value x of the inputted image X (i, j) is carried out, and it is outputted.

[0017]By carrying out the multiplication of the pixel value x of the inputted image X outputted from the delay circuit 4 (i, j) by gain correction coefficient g (i, j), the multiplication circuit 5 amends the pixel value x of the inputted image X (i, j) by gain correction coefficient g (i, j), and outputs the picture Z by the pixel value z (i, j).

[0018]In this embodiment, by setting gain correction coefficient g (i, j) as one or less value, the multiplication circuit 5 will output here the picture Z by the pixel value z (i, j) which compresses the dynamic range of the inputted image X, as shown in drawing 2 (D). By generating gain correction coefficient g (i, j) so that a value may change rapidly in the portions of the smoothed image S twist which comes to remove change of a small pixel value saving edge furthermore, and edge, In other portions except edge, the picture Z by the pixel value z (i, j) is generated by the tendency into which only the portion of edge curtailed change of the pixel value, with change of the small pixel value in the inputted image X saved. That is, only the global dynamic range of a picture is compressed selectively and the picture Z is generated.

[0019]Thereby, by this embodiment, the unnatural edge enhancement by the fall of the contrast feeling into which it comes to compress change of a small pixel value, and change of a frequency characteristic is avoided effectively, and it is made as [output / the picture Z which compresses a dynamic range with a high compression ratio].

[0020]The look-up table (LUT) 6 is carried out in this way, sets up eventually the characteristic of the picture Z which compresses a dynamic range, and generates the outputted image Y. That is, the look-up table 6 is set as the input-output behavioral characteristics which compress the gradation near white near the black, as shown in drawing 4. In the dynamic range of image data with which the look-up table 6 is outputted from the multiplication circuit 5 by this, The saturation of the gradation in the portion exceeding the dynamic range of the outputted image Y is prevented, and it is made as [avoid / the situation where gradation is lost / near self-, near the black / in the outputted image Y / effectively].

[0021](1-2) Non-line type smoothing machine drawing 5 is a block diagram showing the composition of the non-line type smoothing machine 2. In this non-line type smoothing machine 2, the low pass filter (LPF) 11, It is constituted by the two-dimensional linearity low pass filter which smooths the inputted image X, and generating of a punctiform noise is prevented by subsequent processings by smoothing the pixel value x in the inputted image X (i, j) to some extent a priori. Even if the low pass filter (LPF) 11 depends, it can perform same processing.

[0022]The look-up table (LUT) 12 log transforms and outputs the pixel value of image data F1 outputted from the low pass filter (LPF) 11, A pixel value is smoothed with the pixel value logarithm-ized in the processing after this continues, and the grade of smoothing is kept from changing with pixel values.

[0023]Advanced epsilon filter 13AX is the filter which changed some non-line type smoothing filters called epsilon filter, and it smooths and outputs a pixel value about the horizontal direction of the inputted image L1 inputted from the look-up table 12, with edge saved.

[0024]Continuing advanced epsilon filter 13BX is the same non-line type smoothing filter as advanced epsilon filter 13AX, and it smooths and outputs a pixel value about the horizontal direction of the inputted image L2 inputted from advanced epsilon filter 13AX, with edge saved. Advanced epsilon filter 13BX is constituted identically to advanced epsilon filter 13BX except for the point that the sampling pitch with which processing of smoothing is presented differs from advanced epsilon filter 13BX, when the time delay in the delay circuit mentioned later differs from advanced epsilon filter 13AX.

[0025]In the non-line type smoothing machine 2, it connects in series and only the number of specified stages arranges advanced epsilon filter with which the sampling pitches with which processing of such smoothing is presented differ. Thereby, with the non-line type smoothing machine 2, when processing of smoothing is performed to change of the pixel value of each frequency component corresponding to each sampling pitch, respectively and it sees as the whole frequency band, it is made as [perform / over a large frequency band / fully / processing of smoothing].

[0026]Advanced epsilon filter 13AY, 13BY, and .... are perpendicularly constituted

identically to advanced epsilon filter 13AX, 13BX, and .... except for the point of performing processing of smoothing. For this reason, these advanced type epsilon filter 13AY, 13BY, and advanced epsilon filter 13AY of .... that is the first rank are made as [input / via the memory which is not illustrated, / the arrangement of image data is changed and]. The non-line type smoothing machine 2 performs processing of smoothing by these in a large frequency band, horizontal and saving edge perpendicularly.
[0027]The look-up table (LUT) 14 performs and outputs processing of inverse logarithm conversion conversely [the look-up table 12] to the image data smoothed by advanced epsilon filter 13AY, 13BY, and .... As opposed to the outputted image L2 of the look-up table 14 which the low pass filter (LPF) 15 is the same linearity low pass filter as the low pass filter 11, and it comes to smooth by saving edge, Edge is dulled slightly, the field near the edge of the outputted image Y is smoothed by this, and the sense of incongruity by a series of processings is prevented.
[0028](1-2-1) Below, advanced epsilon filter advanced type epsilon filter 13AX explains the composition of advanced epsilon filter 13AX by contrast with epsilon filter by being the filter which carried out the partial change of the composition of common epsilon filter. Advanced epsilon filter 13BX and .... explain suitably the part which starts this different composition by [as advanced epsilon filter 13AX / same] being composition here except for the point that the sampling pitches with which processing of smoothing is presented differ, and the duplicate explanation is omitted. If attached to advanced epsilon filter 13AY, 13BY, and ...., except for the point that the entry sequenced forewords of the image data which is a processing object differ, the explanation duplicate here is omitted advanced epsilon filter 13AX, 13BX, ..., by being an identical configuration.
[0029]In the case of 2N+1 tap by one dimension, the usual epsilon filter can express input-output behavioral characteristics with a following formula here. s_n is an output value here, r_n is an input value, and epsilon is a predetermined reference value. r_n is an input value of the center of a processing object, and a_k is a weighting factor. The range of the sigma of the 2nd formula is the range of k=-N to k=N.
[0030]
[Equation 1]

$$s_n = \Sigma a_k \cdot w_{n-k}$$

$$\Sigma a_k = 1$$

$$|r_n - r_{n-k}| \leq \varepsilon \text{ のとき} \quad w_{n-k} = r_{n-k}$$

$$|r_n - r_{n-k}| > \varepsilon \text{ のとき} \quad w_{n-k} = r_n \quad \cdots\cdots (1)$$

[0031]As this is shown in drawing 6 (A), when calculating output-value s_n in epsilon filter about pixel p_n which is pixel value r_n, among pixel p_l which is an object of

calculation - p_{2N+1}, Absolute value ** r_n-r_{n-k} ** for the pixel value difference to central pixel value r_n about bigger pixel p_{n-k} than the reference value epsilon. The pixel value r_{n-k} is transposed to central pixel value r_n, About pixel p_{n-k} below the reference value epsilon, pixel value r_{n-k} of this pixel p_{n-k} is used for absolute value ** r_n-r_{n-k} ** for this pixel value difference, and processing of weighting addition is performed.

[0032]Namely, as shown [epsilon filter] in drawing 6 (A), when calculating output-value s_n of pixel P_n, in a pixel before and behind this pixel P_n, About pixel p_m from which pixel value r_m differs by making the reference value epsilon into a judging standard more greatly than pixel P_n. As shown in drawing 6 (B) with comparison with processing by a mere line type low pass filter, while it calculates pixel value r_m by transposing it to pixel value r_n and this had saved edge, change of a small pixel value is oppressed.

[0033]However, when it is this method, a pixel value is judged with the reference value epsilon focusing on value r_n of pixel P_n which computes an output value, By calculating output-value s_n by carrying out weighting addition by the replacement with pixel value r_n of pixel P_n, fully smoothing becomes difficult when direct current level is changing, as shown in drawing 7 to the ability to save edge and oppress change of a small pixel value like both sides of edge which drawing 6 showed when the pixel value x is changing with the direct current level of about 1 law.

[0034]That is, when direct current level of the input value r is increasing or decreasing gradually, a pixel number contained to a field by the reference value epsilon decreases as it keeps away from P_n which computes output-value s_n. In this case, even if it carries out weighting addition by replacement of value r_n of pixel P_n, smoothing will be correctly processed reflecting change of direct current level.

[0035]For this reason, according to this embodiment, by contrast with (1) type, as shown in a following formula, change of direct current level is approximated by a fixed function, a field (2epsilon1) is set up by this function focusing on pixel value r_n of pixel P_n, and a pixel value is judged. About a pixel which jumps out from this field, it transposes to a pixel value on this function, and processing of smoothing is performed. The range of a sigma of the 2nd formula in (2) types is the range of k=-N to k=N, and a range of the range of a sigma of the 2nd formula in (3) types is s=-M to s=M-1 here.

[0036]

[Equation 2]

$$
\begin{aligned}
& s_n = \Sigma a_k \cdot w_{n-k} \\
& \Sigma a_k = 1 \\
& | r_n - v_{n-k} | \leqq \varepsilon 1 \text{のとき} \quad w_{n-k} = r_{n-k} \\
& | r_n - v_{n-k} | > \varepsilon 1 \text{のとき} \quad w_{n-k} = r_n + K_a \cdot k \quad \cdots\cdots (2)
\end{aligned}
$$

[0037]

[Equation 3]

$$v_{n-k} = r_{n-k} - K_a \cdot k$$

$$K_a = \frac{\Sigma r_{s+1} - r_s}{(2M-1)} \quad \cdots\cdots (3)$$

[0038]Here, a linear function is applied to this function, straight-line approximation is carried out and change of such direct current level is processed. That is, average value K_a of the slope of a line which connects between the adjoining pixels in 2 M pixels before and after calculating output-value s_n is calculated, a field is further set up on the basis of average value K_a of this inclination, a pixel value is judged, and a pixel value is replaced so that it may be further located on this straight line. Thereby by this embodiment, it is made as [perform / processing of smoothing], certainly saving edge much more as compared with the former. The case of K_a=0 of advanced epsilon filter is the characteristic with common epsilon filter explaining drawing 6.

[0039]Drawing 8 is a block diagram showing advanced epsilon filter 13AX. This advanced epsilon filter 13AX inputs the pixel value r concerning data smoothing into delay circuit (D) 21A-21F by a predetermined time delay one by one, and, thereby, is constituted by seven taps. The series connection of the registers 22A-22N of the number of specified stages (m pieces) is carried out, and these delay circuits 21A-21F are constituted here, as shown in drawing 9. Thereby, advanced epsilon filter 13AX is made as [choose / by a sampling pitch according to a number of stages (that is, it corresponds to a time delay of the delay circuits 21A-21F) of the register sequences 22A-22N / the pixel value r of 7 samplings (i, j)].

[0040]it writes -- advanced epsilon filter 13AX in carrying out, Thus, by choosing the pixel value r by a sampling pitch corresponding to a number of stages of the registers 22A-22N, and processing, Processing of smoothing is performed around a pixel which calculates that part and the output value s using a pixel value of a wide range, and it is made as [simplify / processing of the latter part corresponding to this wide range]. If processing of smoothing is performed using a pixel value of a range wide in this way, change of a pixel value by that much low frequency can fully be oppressed.

[0041]In advanced epsilon filter 13BX and ...., It is set up so that a time delay of the delay circuits 21A-21F which are constituted and correspond so that a number of stages of this register may differ from this advanced epsilon filter 13AX may differ from this advanced epsilon filter 13AX, It is made as [perform / with a different frequency characteristic by this from this advanced epsilon filter 13AX / processing of smoothing].

[0042]The inclination calculation circuit 24 (drawing 8) by inputting a pixel value inputted into the delay circuit 21A of the first rank with an output value of these delay circuits 21A-21F, r (i, j) of 7 samplings corresponding to a time delay of the delay circuits 21A-21F is inputted, and the average value ka of inclination is calculated and outputted by performing data processing of (3) types.

[0043]Inside of a pixel value of seven taps to which the arithmetic circuits 25A-25F are outputted from the delay circuits 21A-21F, respectively, Each tap output r_{n-3m} except output-value r_n of a center tap, r_{n-2m}, r_{n-m}, r_{n+m}, r_{n+2m}, About r_{n+3m}, data processing of the 3rd formula and the 4th formula in (2) types is performed, and result-of-an-operation w_{n-3m}, w_{n-2m}, w_{n-m}, w_{n+m}, w_{n+2m}, and w_{n+3-m} are outputted. m is a number of stages of a register in the delay circuits 21A-21F here.

[0044]Namely, the arithmetic circuit 25A (25B-25F), As shown in drawing 10, input the average value ka of inclination in the multiplication circuit 28, and here, respectively Each tap output r_{n-3m}, r_{n-2m}, r_{n-m}, r_{n+m}, r_{n+2m}, Carry out the multiplication of the distance k from a center tap corresponding to r_{n+3-m}, and this inclines, and about a linear function by K_a. Deviation K_ak from center tap output r_n in a sampling point of each tap output r_{n-3m}, r_{n-2m}, r_{n-m}, r_{n+m}, r_{n+2m}, and r_{n+3-m} is calculated (refer to (2) types and (3) types).

[0045]The subtractor circuit 29 calculates and outputs v_{n-k} in (2) types by subtracting output-value K_ak of this multiplication circuit 28 from each tap output r_{n-3m}, r_{n-2m}, r_{n-m}, r_{n+m}, r_{n+2m}, and r_{n+3-m}.

[0046]The subtractor circuit 30 calculates and outputs (r_n-v_{n-k}) in (2) types by subtracting output-value v_{n-k} of this subtractor circuit 29 from center tap output r_n.

[0047]The absolute value-ized circuit 31 calculates and outputs ** r_n-v_{n-k} ** in (2) types by absolute-value-izing an output value (r_n-v_{n-k}) of this subtractor circuit 30.

[0048]The comparison circuit (CMP) 32 by comparing output-value ** r_n-v_{n-k} ** of this absolute value-ized circuit 31 with the reference value epsilon 1 for field setting out mentioned above about drawing 7, (2) Perform processing of a size judgment in a formula and output a decision result as a switching signal of a selector (SEL).

[0049]The adder circuit 34 calculates and outputs r_n+K_a and k in (2) types by adding output-value K_ak of center tap output r_n and the multiplication circuit 28.

[0050]The selector 33 with the switching signal SEL outputted from the comparison circuit 32. Tap output r_{n-3m}, r_{n-2m}, r_{n-m}, r_{n+m}, r_{n+2m}, r_{n+3m}, or output-value r_n+K_a and k of the adder circuit 34 is outputted selectively respectively.

[0051]Arrange so that a position of pixel value r_n of pixel p_n in which a linear function by inclination by which the arithmetic circuit 25 was calculated by these in the inclination calculation circuit 24 calculates the output value s may be passed, and. A field of the value epsilon 1 is set as the upper and lower sides of a straight line by this arrangement, about a pixel of which a pixel value jumps out from this field, it judges with edge, a pixel value on this straight line is replaced, and the result of an operation is outputted [pixel / in this field] with an original pixel value of this pixel.

[0052]The weighting circuits 36A-36G carry out weighting of an output value of the arithmetic circuits 25A-25F, or the output value of a centre tap with (drawing 8) and a weighting factor corresponding to each tap output, respectively, and output, and this performs data processing of each item of a sigma in the 1st formula in (2) types.

[0053]The adder circuit 37 adds an output value of these weighting circuits 36A-36G,

performs data processing of the 1st formula in (2) types by this, and outputs a processing result.

[0054](1-2-2) the look-up table 3 -- drawing 11 is a characteristic curve sheet showing the gray-scale-conversion characteristic of low frequency components by this image processing circuit 1 here. Input-output behavioral characteristics are set up with the gray-scale-conversion characteristic which shows the look-up table 3 in drawing 11.

[0055]That is, it is made for an output value corresponding to a case where the pixel value s max by low frequency components is inputted with the biggest value to serve as s cmp in this image processing circuit 1 so that the characteristic with the numerals L2 may show. In this case, the compression ratio g1 of a dynamic range is expressed with scmp/s max. It is made to output an output value by the profit 1 to an input value in a range to the pixel value s1 by low frequency components so that it may be expressed by the numerals L2. The pixel value s1 shall be made into a value smaller than upper limit of a dynamic range of an outputted image, and there shall be no necessity of daring to compress gradation, about a pixel value not more than value s1 in the inputted image X.

[0056]The look-up table 3 is made as [set / using the transfer characteristic (the numerals L1 show) of the profit 1 which is the transfer characteristic to this pixel value s1 / by the operation which carries out division process of the value of each vertical axis according to the transfer characteristic with these numerals L1, and is expressed by the numerals L2/L1 / input-output behavioral characteristics].

[0057](2) In composition beyond operation of a 1st embodiment, in the image processing circuit 1 (drawing 1), the inputted image X by an image pick-up result etc. is inputted into the non-line type smoothing machine 2 (drawing 2 (A) and (B)), data smoothing is carried out, saving edge here, and the smoothed image S is generated. In this smoothed image S, saved edge and by carrying out data smoothing here, An ingredient which determines contrast of a photographic subject in which to save without [independent of a dynamic range of a picture] compressing is desired will be removed, and only an ingredient which determines a dynamic range of a picture will be taken out independently.

[0058]In the image processing circuit 1, access the look-up table 3 with this smoothed image S, and gain correction coefficient g (i, j) is generated one by one (drawing 2 (C) and drawing 3), The multiplication of the pixel value x of the inputted image X inputted via the delay circuit 4 (i, j) is carried out in the multiplication circuit 5, and a dynamic range of the inputted image X is compressed (drawing 2 (D)). When the pixel value x (i, j) is amended in the inputted image X by gain correction coefficient g (i, j) by the smoothed image S which is only an ingredient which determines a dynamic range of a picture at this time, While it had been saved about change of a local pixel value, and edge of a picture, only change of a global pixel value is curtailed selectively and generated, degradation of a contrast feeling which is the contrast of appearance by this is prevented, and the picture Z into which it fully comes to compress a dynamic range is

generated. Also about edge, change of a frequency characteristic is prevented and, thereby, unnatural emphasis of edge is prevented.

[0059]In the image processing circuit 1, do in this way and a dynamic range by access of the look-up table 6 by a pixel value of the picture Z which it comes to compress (Drawing 1 and drawing 4), Gradation near white near the black is compressed selectively, even if it is a case where the inputted image X by a thereby very big dynamic range is inputted, a situation where gradation is lost near white near the black is avoided effectively, and the outputted image Y is outputted.

[0060]Thereby, in the image processing circuit 1, for example in imaging devices, such as a video camera and an electronic "still" camera, record reproduction of the image pick-up result can be carried out by a record reproduction system in which a dynamic range is narrower than an image pick-up result, and degradation of grace of an image pick-up result can be prevented. In an imaging device, a large image pick-up result can be obtained to a dynamic range as compared with such usual by composition etc. of a picture from which sensitivity differs by selection of an image sensor again. When applying to an image display device and displaying a large picture of such a dynamic range, a high-definition picture can be displayed.

[0061]it applying to picture amendment of backlight correction etc., picture composition by a computer, and image processing, and, even if it boils and processes various pictures by a large dynamic range, Such various processings can also be processed high-definition by the ability transmitting a processing result, recording and reproduce [preventing degradation of grace,]. When it applies to picture transmission equipment, it avoids effectively, and picture transmission of the degradation of image quality can be carried out at high speed.

[0062]Thus, in [in saving an edge component and smoothing a pixel value] the (drawing 5) non-line type smoothing machine 2 in the image processing circuit 1, After the low pass filter 11 band-limits the pixel value x of the inputted image X (i, j), processing of smoothing which saved edge by advanced epsilon filter 13AX and .... is performed, and, thereby, a punctiform noise in the outputted image Y is prevented.

[0063]By band-limiting the smoothed image S by the low pass filter 15 of a final stage of this non-line type smoothing machine 2, change of an unnatural pixel value near the edge is reduced, and the outputted image Y in which it comes to express the neighborhood of edge smoothly by this is obtained.

[0064]After performing processing of smoothing which furthermore log transformed the pixel value x (i, j) by the look-up table 12, and saved edge, Inverse logarithm conversion is carried out by the look-up table 14, the smoothed image S is generated, a difference of a processing result by a pixel value in a processing result of smoothing is prevented by this, and compression of an unnatural dynamic range in the outputted image Y is prevented.

[0065]After processing of filtering which saves edge one by one and furthermore

oppresses a high frequency component by advanced epsilon filter 13AX, 13AX, and .... is performed horizontally, by continuing advanced epsilon filter 13AY, 13AY, and .... It becomes possible to generate the outputted image Y which same processing is performed perpendicularly, and secures perpendicularity, a horizontal direction, and still more sufficient contrast feeling for an oblique direction by this, and prevents unnaturalness of edge.

[0066]In advanced epsilon filter 13AX which performs filtering processing which saved edge one by one for all directions still in this way, 13AX, ..., 13AY, 13AY, and ...., Repeat execution of the processing of filtering is carried out by a different sampling pitch, and, thereby, the smoothed image S which it comes to smooth in a large frequency band enough with information on edge saved is generated in the image processing circuit 1. Thereby, processing of smoothing can be performed so that only a specific frequency component may not remain in such a smoothed image S selectively, and image quality deterioration of the partial output picture Y can be avoided effectively in the image processing circuit 1.

[0067]Each advanced epsilon filter 13AX, 13AX, ..., 13AY, 13AY, In .... (drawing 7 and drawing 8), the pixel value r is inputted into a series circuit of the delay circuits 21A-21F one by one, and a value of each of other tap output is judged on the basis of a center tap output in the arithmetic circuits 25A-25F, respectively about these seven tap outputs depended delay circuit 21A-21F (drawing 10). Furthermore, when a pixel value changes greatly to a center tap output with these judgments, it is judged with a thing over edge, This greatly different pixel value is transposed to a predetermined value, weighting addition between these center tap output and other tap outputs is performed by the weighting circuits 36A-36F and the adder circuit 37, and processing of smoothing is performed.

[0068]On this processing and in each advanced epsilon filter 13AX, 13AX, ..., 13AY, 13AY, and ...., When each delay circuits 21A-21F are constituted by series circuit which are the registers 22A-22N, a continuous pixel value is sampled with a pitch by this number of registers that carried out the series connection, and processing of smoothing is performed. Thereby, about the arithmetic circuits 25A-25F, the weighting circuits 36A-36F, and the adder circuit 37, only a number corresponding to this tap output can be arranged, processing of smoothing can be performed, and that part entire configuration can be simplified. About a pixel value which is a processing object of smoothing. As compared with composition of these arithmetic circuits 25A-25F, the weighting circuits 36A-36F, and the adder circuit 37, processing of smoothing can be performed using a pixel value of a wide range, and it can fully smooth also about pulsation by low frequency thereby, for example.

[0069]In these each advanced epsilon filter 13AX, 13AX, ..., 13AY, 13AY, and .... in the image processing circuit 1, By being set up so that number of stageses of these registers 22A-22N constituted delay circuit 21A-21F may differ, as mentioned above,

repeat execution of the processing of filtering is carried out by a different sampling pitch, and image quality deterioration of the outputted image Y is prevented.

[0070]Thus, in processing which carries out an edge judging on the basis of a center tap output, and replaces a pixel value, An edge judging is carried out [each advanced epsilon filter 13AX, 13AX, ... and] by whether in 13AY, 13AY, and ...., low frequency components of each tap output are approximated to a predetermined function, a field (2epsilon1) is set up by this function on the basis of a center tap output (drawing 7), and this field belongs. In each advanced epsilon filter 13AX, 13AX, ..., 13AY, 13AY, and .... by this, When a pixel value is in an increase tendency gradually, when it is decreasing, even if it is, like a case where a tendency of such change is not seen, edge can be judged and, thereby, degradation of the outputted image Y by change of such a judgment can be prevented.

[0071]Even when judging with a portion of edge and replacing a pixel value, a pixel value of replacement is determined on the basis of a function searched for by doing in this way, An outputted image can be made further much more high-definition at a weighting processing result which replaces a pixel value by this and is searched for reflecting change of a pixel value by such low frequency.

[0072]Furthermore, by this embodiment, by applying a linear function as this function, it can only ask for inclination of a straight line, and a series of processings can be performed by simple composition which performs processing of a judgment etc. by this inclination further.

[0073]That is, a difference value is calculated between each advanced epsilon filter 13AX, 13AX, ..., a tap output that adjoins out of seven tap outputs in the inclination calculation circuit 24 in 13AY, 13AY, and ...., and average value K_a of inclination is calculated by equalization of this difference value. Furthermore in each arithmetic circuits 25A-25F, about a sampling position of other tap outputs except a center tap, with average value K_a of this inclination, and the distance k from a center tap position. Difference value $K_a k$ from a center tap output in a case of being based on this inclination is calculated in the multiplication circuit 28, A difference value of a pixel value on a function by this inclination K_a and a pixel value by a actual tap output is calculated in the continuing subtractor circuits 29 and 30, and it is judged in the comparison circuit 32 whether this difference value is larger than the reference value epsilon 1. Thereby, decision processing of being edge is performed using approximation functions by a linear function.

[0074]Furthermore, on the other hand, a pixel value on a function by this inclination K_a is calculated in the adder circuit 34, When the selected output of the pixel value on a function calculated by having done in this way with a actual tap output is carried out according to a decision result in the comparison circuit 32 and this straddles edge, It is outputted to a weighting circuit where it is transposed to a pixel value calculated using approximation functions by a linear function, and each tap output corresponds.

[0075]Degradation of edge and a fall of a contrast feeling can be prevented by these in the image processing circuit 1 about the inputted image X by various image quality with a large dynamic range, and a dynamic range can fully be compressed.
[0076](3) by smoothing the inputted image X, with edge saved, asking for gain correction coefficient g, and amending a pixel value of an inputted image by this gain correction coefficient g according to composition beyond an effect of a 1st embodiment, A fall of a contrast feeling, unnatural edge enhancement, etc. are avoided effectively, and it enables it to compress a dynamic range with a high compression ratio.
[0077]After doing in this way and compressing a dynamic range, loss of gradation [/ near white near the black] is effectively avoidable by amending gradation by the look-up table 6 further.
[0078]When smoothing the inputted image X, saving edge in this way, after a low pass filter band-limits, by log transforming and processing and carrying out inverse logarithm conversion of the processing result, generating of a punctiform noise can be prevented and a difference of a processing result by a pixel value can be prevented.
[0079]When smoothing the inputted image X, saving edge furthermore, by repeating several filtering from which a sampling pitch differs, it can smooth uniformly in a large frequency band, and, thereby, the outputted image Y by high grace can be outputted.
[0080]By sampling a continuous pixel with a predetermined pitch and performing processing of this smoothing, A pixel value of a wide range can be sampled by simple composition, processing of smoothing can be performed, processing of smoothing can fully be performed also about low frequency by this, and the high-definition outputted image Y can be obtained.
[0081]In processing of this smoothing, the high-definition outputted image Y can be obtained also by calculating a pixel value of replacement further using this function by approximating a function with a pixel value, setting up a field by this function and carrying out an edge judging.
[0082]An entire configuration can be simplified by furthermore having made this function into a linear function.
[0083](4) The 2nd embodiment drawing 12 is a block diagram showing an image processing circuit which starts a 2nd embodiment of this invention by contrast with drawing 1. In this image processing circuit 41, the same composition with the image processing circuit 1 attaches corresponding numerals, it is shown and duplicate explanation is omitted.
[0084]Like the image processing circuit 1, as shown in drawing 13, this image processing circuit 41, A dynamic range of the inputted image X is compressed by gain correction coefficient g (i, j) (drawing 13 (C)) which smooths the inputted image X (drawing 13 (A)) by the pixel value x (i, j), generates the smoothed image S (drawing 13 (B)), and is generated from the pixel value s of this smoothed image S (i, j). In this processing, the image processing circuit 41 emphasizes change of the pixel value y of

the outputted image Y (i, j) using subtraction value x(i, j)-s (i, j) produced by subtracting the output value s by data smoothing (i, j) from the pixel value x of the inputted image X (i, j).

[0085]That is, in this image processing circuit 41, the subtractor circuit 42, the multiplication circuit 43, and the adder circuit 44 are arranged one by one between the delay circuit 4 and the multiplication circuit 5. From the pixel value x of the inputted image X (i, j), the subtractor circuit 42 subtracts the output value s by data smoothing (i, j), and outputs subtraction value x(i, j)-s (i, j) here (drawing 13 (D)). The continuing multiplication circuit 43 amplifies this subtraction value x(i, j)-s (i, j) by the predetermined profit K (drawing 13 (E)), and the adder circuit 44 adds the pixel value s of the smoothed image S (i, j) to an output value of this multiplication circuit 43. By this, this image processing circuit 41 carries out the multiplication of the added result of the adder circuit 44 which emphasizes small pulsation removed with the non-line type smoothing machine 2 in the multiplication circuit 5 as compared with the inputted image X, and generates the outputted image Y, Thus, it is made as [output / as compared with a part which processes a picture which emphasizes small pulsation, and the image processing circuit 1 mentioned above about drawing 1 / what is called a sharp picture].

[0086]emphasizing change of the pixel value y of the outputted image Y (i, j) using subtraction value x(i, j)-s (i, j) produced by subtracting the output value s by data smoothing (i, j) from the pixel value x of the inputted image X (i, j) according to composition shown in drawing 12 -- an effect of a 1st embodiment -- in addition, A more sharp picture can be outputted.

[0087](5) The 3rd embodiment drawing 14 is a block diagram showing an image processing circuit which starts a 3rd embodiment of this invention by contrast with drawing 12. In this image processing circuit 51, the same composition with the image processing circuit 41 attaches corresponding numerals, it is shown and duplicate explanation is omitted.

[0088]In this image processing circuit 51, the look-up table (LUT) 52 is accessed with the output value s of the smoothed image S (i, j), and a profit in the multiplication circuit 43 is set up. In this look-up table 52, as shown in drawing 15, input-output behavioral characteristics are set up here. Thereby, the look-up table 52 will set up a profit approach the value 1 gradually, if the multiplication circuit 43 is set as a fixed profit and the output value s (i, j) increases beyond this predetermined value, when the output value s (i, j) is below a predetermined value.

[0089]Thereby about a field where a pixel value is big, it is made as [reduce / a grade which emphasizes contrast] in the image processing circuit 51. Namely, in a general picture, if contrast was also as large enough as [near the pixel with a large pixel value] in many cases and it emphasized contrast uniformly, Such near the pixel, contrast will be emphasized more than needed, and in the part processing result, grace deteriorates

and is observed. However, if a grade which emphasizes contrast is reduced like this embodiment about a field where a pixel value is big, a high picture of grace natural as a whole can be outputted.
[0090]According to composition shown in drawing 14, a high picture of grace can be outputted further much more by changing a grade emphasized according to a pixel value.
[0091](6) The 4th embodiment drawing 16 is a block diagram showing an image processing circuit which starts a 4th embodiment of this invention by contrast with drawing 12.
[0092]As this image processing circuit 61 is shown in drawing 17, after removing a noise of the inputted image X a priori with the noise rejection filter 62, by the continuing multiplication circuit 63. Multiplication is carried out by a uniform profit, a dynamic range is expanded (drawing 17 (A) and (B)), a dynamic range is compressed by the image processing circuit 1, and it outputs with a dynamic range of the original inputted image X (drawing 17 (C)).
[0093]Coring processing with the common noise rejection filter 62, a median filter, epsilon filter, or advanced epsilon filter is applied here. In this embodiment, conversely, above a predetermined pixel value, the image processing circuit 1 amends a pixel value by a fixed profit, and with the characteristic mentioned above about drawing 3, in the range below a predetermined pixel value, it amends a pixel value so that a profit may fall.
[0094]According to composition shown in this drawing 16, about a picture in which contrast, such as a backlight picture, is extremely high, degradation of image quality can be avoided effectively and processing of amendment of gradation, etc. can be performed.
[0095]That is, in an image processing circuit mentioned above about drawing 1 etc., without lowering, by amending a pixel value with the characteristic by monotone decreasing as shown in drawing 3, only a bright portion will lower brightness and brightness of a dark portion of the inputted image X will compress a dynamic range. However, making it not become bright any more, in this embodiment, only a dark portion can raise brightness, and the portion which has a moderate luminosity of the inputted image X by compressing a dynamic range with the characteristic contrary to this can compress the whole contrast by it. Thereby, processing of backlight correction etc. can be performed.
[0096](7) The 5th embodiment drawing 18 is a block diagram showing an image processing circuit concerning a 5th embodiment of this invention. In this image processing circuit 71, the matrix circuit 72 carries out data processing of red and the blue and green chrominance signal R, B, and G, and generates the luminance signal Y, color-difference-signal R-Y, and B-Y.
[0097]The image processing circuit 1 compresses and outputs a dynamic range of the luminance signal Y by processing this luminance signal Y selectively. When [which write] this image processing circuit 71 compresses a dynamic range selectively only

about the luminance signal Y in this way in carrying out in the image processing circuit 1, It is made as [prevent / prevent change of a ratio of a signal level between red and the blue and green chrominance signal R, B, and G, and / change of hue by change of this ratio].

[0098]The dividers 73 and 74 normalize color-difference-signal R-Y and B-Y with the luminance signal Y by carrying out division process of color-difference-signal R-Y and B-Y with the luminance signal Y, respectively. a part of processing [in / for color-difference-signal R-Y and B-Y to which the delay circuits 77 and 78 are outputted from these dividers 73 and 74 / the image processing circuit 1] -- you make it delayed and it outputs. The multiplication circuits 77 and 78 amend a pixel value of a color-difference signal by which the normalizing process was carried out with the dividers 73 and 74 by carrying out the multiplication of the luminance signal Y outputted to color-difference-signal R-Y outputted from the delay circuits 77 and 78, respectively, and B-Y from the image processing circuit 1.

[0099]Namely, in [even if it is a case where a dynamic range of only a luminance signal is compressed] a color-difference signal, Chroma saturation will become high, when not amending a signal level of a color-difference signal at all by being a differential signal of a luminance signal and a chrominance signal, and a ratio of an ingredient of chroma saturation goes up by a corresponding luminance level and it sees as the whole picture after all with it.

[0100]After normalizing a color difference signal element a priori by a luminance signal component and compressing a dynamic range of a luminance signal component by this embodiment by this, By amending a pixel value of a color difference signal element by which the normalizing process was carried out with a pixel value by this luminance signal component, it is made as [oppress / a dynamic range of a video signal by a color / prevent change of such chroma saturation and / good].

[0101](8) In other embodiments, in addition above-mentioned embodiments, in advanced epsilon filter, although a case where carried out an edge judging by approximation of a primary function, and a pixel value was replaced was described, this invention is approximated, for example by a secondary function etc. not only in this, and may perform these processings.

[0102]In an above-mentioned embodiment, in advanced epsilon filter, although a case where carried out an edge judging by approximation of a function, and a pixel value was replaced was described, this invention may use approximation by a function only for replacement of a judgment of not only this but edge or a pixel value.

[0103]Although a case where sampled a continuous pixel value by a predetermined sampling pitch, and it was processed in advanced epsilon filter in an above-mentioned embodiment was described, If there is this invention when not only this but practically sufficient circuit structure can be secured, it may be made to process a continuous pixel as it is.

[0104]In an above-mentioned embodiment, although a case where an inputted image was smoothed by processing of a repetition with advanced epsilon filter was described, this invention may omit repeated processing, when not only this but practically sufficient characteristic can be obtained.
[0105]In an above-mentioned embodiment, although a case where advanced epsilon filter constituted a non-line type smoothing machine was described, this invention may constitute a non-line type smoothing machine not only with this but with the usual epsilon filter.
[0106]Although a case where the look-up table 6 amended input-output behavioral characteristics eventually was described in an above-mentioned embodiment, This invention may omit processing not only by this but this look-up table 6, and combines it by the look-up table 3, and it may be made to amend the characteristic.
[0107]Although a case where processed a pixel value etc. by each circuit block, and an image processing circuit was constituted was described, it may be made for this invention to constitute not only this but the whole or a part by data processing in an above-mentioned embodiment.
[0108]
[Effect of the Invention]By smoothing an inputted image, with edge saved, calculating a gain correction coefficient, and amending the pixel value of an inputted image with this gain correction coefficient according to this invention, as mentioned above, The fall of a contrast feeling and unnatural edge enhancement can be avoided effectively, and a dynamic range can be compressed with a high compression ratio.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a block diagram showing the image processing circuit concerning a 1st embodiment of this invention.
[Drawing 2]It is a time chart with which explanation of operation of the image processing circuit of drawing 1 is presented.
[Drawing 3]It is a characteristic curve sheet showing the characteristic of the look-up table 3 of the image processing circuit of drawing 1.
[Drawing 4]It is a characteristic curve sheet showing the characteristic of the look-up table 6 of the image processing circuit of drawing 1.
[Drawing 5]It is a block diagram showing the non-line type smoothing machine of the image processing circuit of drawing 1.
[Drawing 6]It is a time chart with which explanation of operation of the non-line type smoothing machine of drawing 5 is presented.

[Drawing 7]It is a time chart with which explanation of advanced epsilon filter of the non-line type smoothing machine of drawing 5 is presented.
[Drawing 8]It is a block diagram showing advanced epsilon filter of the non-line type smoothing machine of drawing 5.
[Drawing 9]It is a block diagram showing the delay circuit of advanced epsilon filter of drawing 8.
[Drawing 10]It is a block diagram showing the arithmetic circuit of advanced epsilon filter of drawing 8.
[Drawing 11]It is a characteristic curve sheet with which explanation of the characteristic of the look-up table 3 of the image processing circuit of drawing 1 is presented.
[Drawing 12]It is a block diagram showing the image processing circuit concerning a 2nd embodiment of this invention.
[Drawing 13]It is a time chart with which explanation of operation of the image processing circuit of drawing 12 is presented.
[Drawing 14]It is a block diagram showing the image processing circuit concerning a 3rd embodiment of this invention.
[Drawing 15]It is a characteristic curve sheet with which explanation of the look-up table 52 of the image processing circuit of drawing 12 is presented.
[Drawing 16]It is a block diagram showing the image processing circuit concerning a 4th embodiment of this invention.
[Drawing 17]It is a time chart with which explanation of operation of the image processing circuit of drawing 16 is presented.
[Drawing 18]It is a block diagram showing the image processing circuit concerning a 5th embodiment of this invention.
[Description of Notations]
1, 41, 51, 61, 71 .... An image processing circuit, 2 .... Non-line type smoothing machine, 3, 6, 12, 14, 52 [.... An inclination detecting circuit, 25A-25F / .... An arithmetic circuit, 62 / .... Noise rejection filter] .... A look-up table, 11, 15 .... A low pass filter, 13AX, 13BX, 13AY, 13BY .... Advanced epsilon filter, 24